In-Service Science Teacher Education in Portugal: An Analysis of The Short Courses Available

Luís DOURADO
Research Centre in Education, Institute of Education
University of Minho, Portugal
ldourado@ie.uminho.pt

Laurinda LEITE
Research Centre in Education, Institute of Education
University of Minho, Portugal
lleite@ie.uminho.pt

Sofia MORGADO
Research Centre in Education, Institute of Education
University of Minho, Portugal
sofiamorgado@ie.uminho.pt

ABSTRACT
Although teaching-related relevant competences development starts during pre-service teacher education programmes, teachers' professional knowledge has to be further developed through in-service training. In-service training should lead teachers to develop and update the knowledge base acquired during initial teacher education and to fulfil their professional needs. In Portugal, in-service training courses are organized by diverse institutions, being the most common higher education institutions and school network training centres. This raises questions about the consistency between science teachers' needs and the in-service training courses offered to them, as well as between the in-service courses and the recent science education research agenda. Courses organized by higher education institutions and school networks from the north of Portugal, accredited by the national agency and available from its webpage, were analysed. Results indicate that in-service training courses focus on diverse teacher education components but they tend to concentrate on general issues. However, it may be hard for science teachers to find in-service training in some subjects and/or issues. These results may motivate a follow up investigation on whether or not those in-service courses fit science teachers' educational needs so that teacher educators can find ways to better make their actions fit teachers' own training needs.

INTRODUCTION

The demands of the teaching profession
Teaching is a complex and demanding task (Dillon & Maguire, 2007; Berry & Loughran, 2012; Wallace & Loughran, 2012; Lederman & Lederman, 2015; Schneider, 2015) as teachers have to play many different roles in school and especially in the classroom (Schneider, 2015). As a matter of fact, Harrison and Killion (2007) argued that a teacher has to be: resource provider; instructional specialist; curriculum specialist; classroom supporter; learning facilitator; mentor; school leader; data coach; catalyst for change; and learner. On one hand, a teacher that is able to play this huge variety of roles is a teacher that acts as a full member of an institution, fosters students' scientifically accurate and methodologically appropriate learning, and promotes his/her own training. The latter is needed for the teacher to keep acquainted with the scientific and technological developments and to fulfil his/her perceived pedagogical practice needs (Ponte, 2006; OECD, 2014a). It is also a teacher that creates learning situations that enables students to develop competences to learn how to learn and to act as informed, responsible and active citizens (Snoek & Zogla, 2009; OECD, 2014a). Besides, it is a teacher that possesses a large body of multidisciplinary knowledge and skills (Ponte, 2006; Snoek & Zogla, 2009; OECD, 2014a) and that feels motivation and enjoyment towards the profession (Blonder, Benny, & Jones, 2014; Kazempour & Sadler, 2015). As Hargreaves (1998) has stated:

> "Good teaching is charged with positive emotion. It is not just a matter of knowing one's subject, being efficient, having the correct competencies, or learning all the right techniques. Good teachers are passionate beings who connect with their students and fill their work and their classes with pleasure, creativity and joy." (p.835).

This is one of the reasons why novice teachers must be supported to develop an awareness of the ways in which emotions influence and shape their work as science teachers (Saka, Southerland, Kittleson, & Hutner, 2013) so that throughout their careers they can fight for their pedagogical goals specially in conflicting settings that are very

common within nowadays accountability driven contexts. Hence, opposite to what some people may think, initial teacher education (ITE) cannot concentrate on subject matter knowledge only (Leite, 2005; Frost, 2010; Eurydice, 2011). Rather, it should lead teachers to acquire multidisciplinary knowledge and to develop competences useful for them to deal with a variety of problem-situation that they may face in their future career (Frost, 2010; Schneider, 2015). Day and Sachs (2004) reinforce this idea when they state that

> "[…] higher quality teaching demands teachers who are well qualified, highly motivated, knowledgeable and skilful, not only at the point of entry into teaching but also throughout their careers." (p.3&4).

If it is acknowledged that "Teachers learn as students learn and students learn as teachers learn" (Wallace & Loughran, 2012, p.295), then the way ITE is carried out becomes a key element for educational success (Rebmann, Schloemer, Berding, Luttenberger, & Paechter 2015). This may be the reason why several researchers have advocated that teacher education should take place in constructivist and diversified environments (Leite, 2005; Wallace & Loughran, 2012), promote teachers' reflection on his/her own learning (Snoeck & Sogla, 2009; NRC, 2010; Rebmann, Schloemer, Berding, Luttenberger, & Paechter, 2015), make them able to critically analyse curriculum innovations and methodologies (Bell, 2005; Leite, 2005; Rebmann, Schloemer, Berding, Luttenberger, & Paechter, 2015) and to resist to the possible mismatches between knowledge conveyed to them during ITE programs and their school counterparts' attitudes and beliefs (Saka, Southerland, Kittleson, & Hutner, 2013).

The newly formed teachers are asked to transfer their initial knowledge base to their new work context, often without any support. Successful knowledge transfer would be possible only if ITE was able to reduce the gap between the theoretical and the practical components of teacher training, to make it easier for novice teachers to cope with the diverse demands that they have to face at once. Otherwise, as Stenberg, Karlsson, Pitkaniemi, and Maaranen (2014) found out, they will concentrate on the didactical issues and neglect the contextual (about school and society, and matters related to content, such as the curriculum) ones.

Anyway, ITE should not be expected to be enough for the newly formed teachers to be able to appropriately deal with the diversity of ever changing problem-situations along their lifespan (Ponte, 2006). In fact, continuous training will be needed (Marcelo, 2009). To be successful, in-service training should be guided by experts or critical colleagues whose mission would be to help teachers to continuously develop as persons, as members of society and as professionals (Bell, 2005) and improve their ways of teaching, interacting with students and engaging into the educational community (Zeichner, 2010; Hénard & Roseveare, 2012).

Science teachers' knowledge and skills

At a first glance, teaching science may seem similar to the teaching of any other subject and the science teachers' knowledge base may be seen as to differ from the knowledge base of other teachers on the subject content knowledge only (Sickel, Banilower, Carlson, & van Driel, 2015). However, teaching science has to take into account the nature of the discipline and the characteristics of the content to be taught (Wallace, 2014) which prospective teachers may not be aware of due to their experiences as learners with science teaching practices that "often carry 'a heavy reliance on didactic teaching styles' and a 'cookbook' approach to investigative work" (Berry & Loughran, 2012, p.401). Besides, as teachers' ideas about science interfere not only with what they teach about science but also with the way they teach it (Wallace, 2014: Anderson, 2015; Henze & van Driel, 2015), Bianchini (2012) argues that science teacher education should convey to the newly formed teachers appropriate ideas about science and scientists' work so that they may convey an updated image of science to their students as well.

In addition, teachers' beliefs about the best ways of teaching science, and their experiences as science learners may inform the ways they teach science (Mansour, 2009; OECD, 2014a). Therefore, in-service teacher education should provide an opportunity for teachers to think about what they do and the way they do it and to find out about the best ways to proceed in order to foster students' learning.

Research has shown that teachers trained under an inquiry learning model may be more likely to adopt more constructivist, student centred forms of learning than if they were trained under a teacher centred approach (OECD, 2014b). These results are consistent with and reinforce the idea that successful teaching depends on the quality of the interaction between teachers and students (Wallace, 2014) and may inform methodological choices in the in-service training context. Besides, different students have different preferred learning styles (Pritchard, 2009; Mestre, 2012; Yassin & Almasri, 2015) and these may depend on the subject content area. This means that in-service teacher education should convey teachers a range of teaching approaches and skills so that at each occasion they can choose the one that best fits their teaching style, and their students' preferred learning styles, conveys an appropriate image of science and facilitates students' science learning.

According to Frost (2010), science teachers need to hold a variety of types of knowledge (including content knowledge, epistemological knowledge, knowledge of teaching and assessment strategies, curriculum knowledge and knowledge about students' learning in science) and to develop a range of attitudes (including attitudes towards science and towards teacher's own professional development) in order to put into practice a science teaching that is consistent with the commonly agreed values and aims of education and the specific goals of science education. Gil-Pérez (1991) also has acknowledged the relevance of these types of knowledge and attitudes but he emphasized the role of research and innovation, placing them at the centre of all the types of knowledge and competences that science teachers should held. He also emphasized teachers' critical awareness towards teachers' spontaneous thinking and towards the usual teaching approaches. In fact, research is the basis for informed pedagogical innovation (Davies, 1999) and the latter requires critical analysis of traditional ways of thinking and doing, so that teaching can be both more effective and motivating, and that learning can be less painful and more meaningful for the learners.

On their analysis of teachers' required types of knowledge, Frost (2010) and Gil-Pérez (1991) focused mainly on the classroom, and did not make it explicit knowledge or abilities required to deal with students that differ from the mainstream. Bianchini (2012) has added that science teachers need to both become aware of the requirements of a curriculum for students with special educational needs and to find the best ways to help these students to make sense of the world.

To help in-service teachers to develop approaches to science teaching that effectively challenge taken-for-granted models and beliefs is a big challenge for teacher educators. As Berry and Loughran (2012) have put it,

> "developing a pedagogy of science teacher education requires educators to be awake to, and aware of, the complex and problematic nature of science and of teaching, as well as having a preparedness to create and engage in experiences that enable genuine learning to take place for all participants in the learning to teach process." (p.413).

Each single teacher should be expected neither to hold all this variety of types of knowledge and skills nor to be able to cope with all the challenging situations a school can offer to teachers. Rather, he/she should be expected to have a basis for professional and personal growth which Hargreaves (1998) conceptualizes as being tied up with the quality, range and flexibility of teachers' classroom work. Therefore, in-service teacher education institutions should do their best in order to promote in-service science teacher education. To achieve this goal, "they must recruit and support teacher educators who have a broad mandate, an expansive world-view, a collaborative approach, and the skills to enact a rich curriculum." (Goodwin & Kosnik, 2013, p.343). The point is that teacher educators become so without taking any training program (Bayrakci, 2009). In addition, there is a variety of profiles of teacher educators (OECD, 2013), ranging from university qualified staff on science education, science or general education to school teachers with a variety of expertise and teaching experience.

Thus, at least four related questions can be raised. First of all, how should in-service teacher educators be prepared and supported to play their role and to do it well? Goodwin and Kosnik (2013) stated that this question cannot yet be answered because the profession has not yet agreed on that teacher educators need formal preparation. Secondly, is there a profile of in-service teacher educator? Traditionally, teacher training has used to be done at higher education institutions (OECD, 2013), which have specialized staff in several areas from content knowledge to general education passing by pedagogical content knowledge and teaching practice. However, some teachers were used to argue that teacher educators from higher education institutions are away from school real life and cannot provide useful in-service training. They would try to fulfil the needs they perception in teachers that act in a school imagined context instead of fulfilling teachers' own (felt) needs in a real context. Hence, recently, there has been an increasing tendency for advocating school-based teacher education done by peers. The argument draws on the idea that peer-tutors can provide school contextualized teacher education that may focus on teachers real (felt) contextual needs and that fit the school real conditions (Hénard & Roseveare, 2012). However, a third question can be asked: as peer tutors are teachers that belong to the same school and are not systematically engaged in research, how can they be aware of new issues that emerge from scientific and educational research and promote educational change? As no one feel the need of what he/she does not know, this would point towards training be done by school-based teacher educators and also by higher education institutions staff. Still, a final question should be raised: is the profile of a teacher educator independent of the subject he/she trains teacher for? It can be argued that even though some dimensions that teachers need to develop are subject independent, other and probably the most important, depend on the subject that is on the content knowledge that they teach. In fact, some of the types of teachers' professional knowledge are specific of a science teacher and would not apply to a language or even a maths teacher.

Teachers' professionalization and professional development: the case of Portugal

As any other professional, a teacher should have an organized body of knowledge that is specific of the teaching profession and of the subject he/she teaches. The specific features of this body of knowledge are what separate teachers from other professionals. To acquire the necessary and varied knowledge-base and to develop the relevant competences to teach in educational changing contexts, those that intend to become teachers need a formal period of preparation to enter the profession, even though they should engage into continuous growth and development actions afterwards (Eurydice, 2015; Ogunniyi & Rollnick, 2015; Schneider, 2015; Treagust, Won, Petersen, & Wynne, 2015). It can be argued that to do ITE is far more than to provide a teaching qualification; it is about forming teaching professionals (Snoek & Zogla, 2009; Lederman & Lederman, 2015), able to not only play a diversity of roles, but also play them well with students holding a wide range of needs and abilities, in a variety of work contexts (Ogunniyi & Rollnick, 2015; Schneider, 2015). However, in contemporary changing societies, societal expectations on teachers are ever changing, and so are the demands on the teaching profession. Therefore, teachers need to be not only professionals but also "proactive in order to respond adequately to the ambiguity, uncertainty and increasing complexity which characterize the educational settings in which they are expected to operate." (Hilton, Flores, & Niklasson, 2013, p.434).

Thus, educating professional teachers is much more than conveying knowledge to prospective teachers; it is about helping teachers to find the best fit among factors that, according to Murray (2014) interact to influence teachers' professionalism: their individual biography, their institutional setting, and the national context. Based on Korthagen's (2010) ideas for ITE, it can be argued for an in-service teacher education model that blends together theory and practice and that acknowledges teachers' previous experiences so that professional learning becomes a bottom-up process taking place in the individual teacher and building from his/her experiences in order to lead to fruitful knowledge development about teaching.

European countries as well as countries in other continents face a common challenge: train effective teachers for the 21st century students' needs (Musset, 2010; Eurydice, 2011; OECD, 2014a). Within the scope of the Bologna process, European member states agreed on a common credit transfer system as well as on a cycles-based structure of higher education. However, they seem to have failed to reach a common framework for ITE (Snoek & Zogla, 2009; Castro, 2015; Lederman & Lederman, 2015) and to agree on a minimum level of qualification (Eurydice, 2015), even though they seem to be aware of the common challenges that teacher education has to face and overcome. Nevertheless, they also failed to design a teacher general profile as well as a subject teacher specific profile. The point is that Member States are different in terms of political orientation and teacher education is very sensitive to politics (Goodwin & Kosnik, 2013) as most governments dictate the kind of teachers they want.

Thus, even though teaching is a universal profession, the teacher profile is heavily influenced by differences on the roles played by the government, the universities, the teachers, and the schools in the educational systems around the world (OECD, 2013). The work context dependency of teacher identity (Flores & Day, 2006; Luehmann, 2007), that is the way teachers see themselves as teachers, may make it hard for teacher education to overcome what Snoek and Zogla (2009) took as one of the most relevant challenges of teacher education - how to promote teachers' identities - as these exerts a meaningful effect on teachers' actions and engagement.

Arguments for in-service teacher education are often associated with curriculum reforms and they are based on the need to make teachers up to date with the newly advocated contents and methods. However, "in modern circumstances, an initial professional training is altogether inadequate for a career which can extend for forty years" (Coolahan, 2002, p26). This is especially true for teachers who seek to equip and motivate their pupils to be lifelong learners. This may explain why professional development for teachers is compulsory at every level in about three-quarters of OECD and partner countries and in some countries it required for promotion or salary increase (OECD, 2014a). In Portugal, the content of in-service training is specified collectively by the central education authorities, teachers' professional organisations, teachers' unions, universities and schools (OECD, 2014b). However, teachers can choose what in-service courses they will engage in given that they can gain a few general credits but that they should gain credits on specific area they teach.

There are several ways of organizing in-service teacher training and the Portuguese law acknowledges a variety of them. Findings from the 2013 teaching and learning international survey (TALIS) suggest that courses are the type of training in which teachers engage more often and that it is followed by conferences or seminars and by participation in teacher networks (OECD, 2014a).

The duration of in-service courses varies from long duration degree leading courses to short-term (being most of them of 25 hours long) or summer courses, or seminar/conference like courses (Coolahan, 2002; OECD, 2014a) and taking in-service courses is part of teachers' contractual obligations (OECD, 2014b), namely in Portugal (Law

22/2014, November 11). Whatever the way it is organized, in most countries, including Portugal, the design of in-service courses has been decentralized and therefore it can be done by the different types of training institution (OECD, 2014b) even though some of them offer more courses than others. However, educational authorities settled accreditation and evaluation systems in order to guaranty quality of the in-service training provided (Eurydice, 2011). Portugal has got both an accreditation system that analyses and eventually accredits the training courses and an evaluation system that audits samples of the training courses that are run. It is called the In-service Scientific and Pedagogic Council (Law 4635/2014, March 31).

Accreditation and evaluation of in-service training courses is guided by the Portuguese law which was first approved in 1992 and that has evolved since then in order to make it clearer the aims focus and types of in-service training courses to be provided to teachers (law 22/2014, November 11). This law states that in-service training should: fulfil the teachers training needs so that they can contribute to the development and improvement of the school educational and curricular project; to the improvement of teaching quality and learning results; teachers' professionals development so that they can give a contribution to the school results; to knowledge dissemination and capacity building so that school and school networks management and autonomy can be reinforced; share knowledge and skills towards teacher professional development. As far as the focus of the training courses is concerned, the Portuguese law states that they should concentrate on areas that coincide with the main teacher education components: content knowledge, pedagogic content knowledge; general education; teaching practice, cultural, social, and ethics knowledge.

In fact, research (Eurydice, 2015; Zhang, Parker, Koehler, & Eberhardt, 2015) has shown that teachers need development and training in some science topics as well as in multiple areas of pedagogical content knowledge. In-service teacher educators have a crucial role to play in meeting the professional learning needs of teachers of the future (OECD, 2013). Their role is very complex because, as O'Dwyer and Atlı (2015) concluded, they have to be more than simply effective teachers of teachers; they have to cater for affective needs, coach a broad range of clients, interpret contextual variables and provide appropriate feedback.

OBJECTIVES

In Portugal, courses specially designed for in-service teacher education purposes are organized by diverse institutions, being the most common higher education institutions (HEI) and school network training centres (SNTC). Most of the times, these institutions organize the courses, publicize them and teachers register in selected courses according to their interest or self-perceived needs. This raises questions about the consistency between teachers' needs and the in-service training courses offered to them, as well as between the in-service courses and the recent science education research agenda. Hence, this paper analysis in-service training courses targeted to science teachers or to teachers who teach science components in order to find out how they respond to these questions and to find out if the answers are the same for both training institutions.

THE STUDY

The open access website http://www.ccpfc.uminho.pt/ shows the in-service training courses accredited by the Portuguese in-service Scientific and Pedagogic Council, in the diverse subject areas and school levels. In March 2015 the website was accessed and the in-service training courses offered by the north of Portugal higher education institutions and school networks were identified. A total of 3106 courses were identified, being 430 offered by higher education institutions and 2776 offered by school networks. Afterwards, some of those courses were selected. They were courses targeted to:

- science teachers, focusing on science content knowledge themes or on science education themes;
- teachers of the diverse subjects, including science teachers. These courses focus on: general educational issues (e.g.: assessment, special education needs) that are relevant for teaching science; cultural, social and ethics themes; educational research issues; teaching practice issues.

The result of this selection was 1555 training courses offered by HEI (190) and by SNTC (1365). However, they include two types of in-service courses: courses specially designed for the purpose of in-service training; seminars/conferences accredited for in-service training purposes. An analysis of the data provided on the 1555 courses showed that 172 were of seminar/conference type. These courses were excluded as they are not specially designed for in-service training purposes. Therefore, 1383 short courses organized for the purpose of in-service training were selected to be analysed. They were offered by HEI (184) and by SNTC (1199). Table 1 synthesises and relates the number of training courses available with the number of in-service training courses analysed, per type of training intuition. It is worth noting that considering the proportion of courses offered by the two types of institutions is similar when the courses available and the courses analysed are considered. This means that the

proportion of courses offered to science all teachers by HEI and by SNTC compares to the one of offered to teachers of other subjects.

The title of the in-service course was content analysed in order to identify the teacher education component it focuses on. Afterwards, those focusing on: science content knowledge were content analysed in order to identify the science area they deal with; science education courses were content analysed in order to identify the science education themes they concentrate on; general education courses were content analysed in order to identify the education issues they deal with. The courses focussing on educational research, on cultural, social and ethics and on teaching practice were not further analysed because there were very few courses in each of these categories.

Table 1: In-service courses offered and analysed, by type of training institution

Type of training institution	Training courses on the website (n=3106)		In-service training courses analysed (n=1383)	
	f	%	f	%
Higher education institution	430	13,8	184	13,3
School networks training centre	2676	86,2	1199	86,7

FINDINGS

Table 2 shows that the majority of the in-service training courses analysed focus on general issues that are relevant to science teaching but do not have a science focus and do not include a science component. A comparison of HEI and SNTC with regard to these two types of training courses indicates that the percentage of training courses dealing with specific issues is larger in the former (38,0%) than it is in the latter (23,8%) type of institution. This difference seems to be mainly due to content knowledge courses (that is courses focusing on science themes) that are offered by HEI (14,1%), through science faculties or equivalent, and that can hardly be organized by SNTC. To offer an in-service training course, training institutions need to have accredited trainers, with an academic degree that is higher than the degree of the training teachers and with a specialization on the area they are to become teacher educators. Thus, it is much easier for universities to offer courses on science knowledge as they have got much more qualified staff on the area than SNTC do. In addition, as there must be a minimum number of trainees for a course to be offered, it is much worth for HEI to offer this type of courses (because they can gather training teachers from different schools) than it is for SNTC that tend to gather teachers from the school network only.

Table 2: Focus of the training courses per type of training institution (%)

(N=1383)

Focus of the training courses		HEI (n=184)		SNTC (n=1199)	
		f	%	f	%
Specific issues (n=355)	Content knowledge themes	26	14,1	19	1,6
	Science education themes	44	23,9	266	22,2
General issues (n=1028)	General educational issues	102	55,4	793	66,1
	Cultural, social and ethics themes	7	3,8	74	6,2
	Educational research issues	2	1,1	1	0,1
	Teaching practice issues	3	1,7	46	3,8

As far as general issues courses are concerned, the percentages of courses are high (over 50%) whatever the type of institution even though HEI differ from SNTC as the latter offer a larger percentage of training courses focusing on the general educational issues than the HEI do. As it will be shown latter, general educational issues is a broad category that includes courses on several themes that can be attended by teachers of every school subject. This may mean that it is worth for SNTC to organize courses on general issues because these courses can gather school network teachers of the different school subjects and therefore it is easy to reach the minimum number of trainees.

The training courses focusing on science content knowledge themes are reduced in number (n=45). They include large scope courses (dealing with interdisciplinary science themes or with a set of topics that belong to diverse science areas) or subject focused courses, concentrating on biology, chemistry, geology or physics (table 3).

Comparing the two types of training institutions, the percentages of physics and science courses offered by HEI surpass those of the SNTC while the percentage of biology and geology courses offered by SNTC surpass HEI. This result may be due to the fact that, as students perceive physics as being a difficult subject (Angell, Guttersrud & Henriksen, 2004), science faculties feel like helping teachers to overcome their lack of knowledge by offering in-service training courses focusing on physics issues. The percentages of courses focusing on chemistry are low,

in both types of institutions. As it is our belief that teachers' chemistry knowledge base also needs to be updated, these so low percentages were unexpected. A consequence of this is that teachers may find it hard to attend an in-service course on Chemistry knowledge to update their content knowledge base.

Table 3: Science scope of the content knowledge training courses (%)

(N=45)

Science scope	HEI (n=26)	SNTC (n=19)	Examples of training courses themes
Science	30,8	21,1	Contemporary science themes; Earth and life science topics
Biology	11,5	26,3	Ethnobotanics; Mycology & environment
Chemistry	3,9	5,2	Biodiesel production; Chemistry, health and environment
Geology	19,2	26,3	Viana do Castelo geologic Patrimony; Geology and sustainability
Physics	34,6	21,1	Topics and history of astronomy; Sound and light waves

Courses on cultural, social and ethics themes, on educational research issues and on teaching practice issues are very few (table 2) and they were not further analysed. However, it is worth noting that educational research is a teacher education component prescribed in the post-Bologna law and that every teacher should hold knowledge on in order to being able to permanently evaluate and improve his/her own teaching practice. Besides, training on the cultural and social components is relevant not only because it is prescribed in nowadays teacher education law but also because teachers need to be aware of the culture and the society characteristics of the school environment if they are going to adopt a science, technology and society perspective. Finally, the ethics component is relevant not only from a teacher own action point of view but also from a student education point of view. In fact, issues like access to information and easy use of text and image raise questions of copyright and authorship that today students need to be educated for using.

As shown by table 4, the science education training courses focus on a variety of themes, whatever the type of institution, even though there are some differences between the courses they offer. The themes compare to those that Mortimer (2002) and Paixão, Lopes, Guerra, and Cachapuz (2008) have identified as being in the science education agenda.

With regard to practical work courses, the percentage of courses offered by HEI is higher than the percentage of courses offered by SNTC. It should be noted that the Portuguese secondary school syllabuses includes a set of laboratory activities that must be performed with/by the students. As some teachers lack laboratory skills, they may look for training courses that concentrate on those activities and HEI may offer them because they want to help teachers and they have appropriate lab equipment to perform those activities.

Table 4: Focus of the science education training courses (%)

(N=310)

Science education issues	HEI (n=44)	SNTC (n=266)	Examples of training courses themes
ICT in science education	13,6	23,3	ICT in science teaching
Practical work	27,3	17,7	Lab activities in science teaching; The Penha mountain as a Geology teaching resource
Health education	20,5	39,8	Sex education in school context; Health education in school for tobacco prevention.
Environmental education	6,8	8,6	Biodiversity, nature conservation and environmental education
Problem-based learning of science	9,1	0,4	The learning of science and geography through PBL
Science, technology and society	2,3	0,8	Applying STEM in the classroom
History of science	4,5	0,0	History of science in science teaching
Science curricula	6,8	3,0	Teaching and learning Environment/Geography Study and the horizontal and vertical curriculum articulation
Science teaching approaches	9,1	4,5	Sound and light: possibilities in the classroom Physical Sciences: a modern and global approach
Other	0,0	1,9	Science and mathematics inclusive teaching strategies

The percentages of information and communication technology (ICT) in science education and of health education courses offered by SNTC are higher than the percentages of courses offered by HEI. Health education is even the area that got the highest percentage of training courses. This may be due to the fact that since 2005 (law 25994/2005, December 16) the ministry of education has been increasingly valuing health education in schools and settling training requirements for teachers that were appointed to engage into health education projects (law 2506/2007, February 20; law-60/2009, August 6, law 196-A/2010 April 9). As some teachers, namely some science teachers (as it is the case of physics and chemistry teachers), have no undergraduate training in health education, then they may put pressure on their school counterparts so that those teachers that fulfil the formal requirements can organize some training on health education in their school or in their school network. In addition, the analysis of the titles of the health education courses suggests that they concentrate on a variety of different issues like healthy life styles, oral health, sex education, nutrition, etc. which also explains the large number of courses offered in the area.

Problem-based learning of science got a higher percentage in the case of HEI (9,1%) than it did in the case of SNTC (0,4%). This may be due to the fact that Problem-based learning is a new methodology in science teaching (Hung, Jonassen, & Liu, 2008) and, as it should be expected, it has to do with a methodological innovation that comes from educational research carried out by HEI and it takes time before school teachers feel comfortable not only to teach with it but moreover to train their counterparts on it. Some history of science in-service training is offered by HEI only. This may be due to the fact that some HEI have specialists on history of science which are not to be expected in the schools.

As far as courses within the scope of general education are concerned, they cover the diverse general education teacher training components (table 5) but there are some differences between HEI and SNTC.

Table 5: Focus of the general education training courses (%)

(N=895)

General educational issues	HEI (n=102)	SNTC (n=793)	Examples of training courses themes
Curriculum development	4,9	0,5	Curriculum horizontal and vertical articulation
ICT	20,6	40,5	Exploration of educational software - Movie Maker
Special educational needs	5,9	12,1	Improving educational practices for students with special needs
Learning difficulties	7,8	8,4	Learning difficulties and educational success
Teacher characteristics	0,0	1,8	The importance of voice and corporal posture in the teaching profession
School management	25,5	12,2	School management
Assessment	14,7	11,9	Students' learning assessment; Supervision and assessment of teacher performance; Schools self-assessment and educational project
Students' misbehaviour	0,0	8,7	Misbehaviour in the school
First aid	0,0	1,4	The basics of first aid in the school context
Educational mediation	20,6	2,5	Conflicts mediation in the school community

The highest percentage of courses was got for ICT courses offered by SNTC, which is about the double of the one obtained for HEI. In today's technologically advanced information societies, ICT is a relevant device to teach science and to make science teaching more appealing to students. Teachers' awareness of this may lead them to look for training in order to try to be updated. However, it may be that they feel afraid of taking in-service training at HEI, which they tend to imagine as being more theoretical and/or complex, and to prefer to do it at SNTC, that they may imagine as being more practice focused.

School management and educational mediation are the areas in which the percentages of courses offered by HEI are higher than the percentages of the courses in the same areas, offered by SNTC. This may be due respectively to the specialization and the novelty of these areas.

In some themes the percentages are similar (e.g., assessment) but in other areas (e.g., special educational needs) they are a bit higher for SNTC. The remaining types of courses are quite rare and some of them are offered by SNTC only. Some of them focus on very practical issues like students' misbehaviour and first aid. Some of these results may be explained by the fact that some schools may have a special education teacher and/or a psychologist which may be asked to organize training for their school teachers, namely on students' behaviour and on special education.

CONCLUSIONS AND IMPLICATIONS

The results of this study suggest that a variety of training courses is available to science teachers and that SNTC offer much more courses than HEI. The courses offered cover the diverse teacher education components but they do it differently. In fact, in some areas a lot of courses are offered but in other areas it may be hard for teachers to find an in-service training course. Of course, teachers can ask for a course in a specific area of their own interest but it requires them to find the right training institution, to take some initiative to get in touch with it and to be lucky to have a teacher trainer available to organize the required training. It is worth noting that the analysis reported in this paper focused on the title of the in-service courses only. Of course research is needed not only in order to find out how the course content is a good development of it and how the courses are put into practice which something that depends partly on the teacher educators that are in charge of it and also on the availability of the resources required.

Institutions that offer in-service training to teachers need to be accredited and therefore the training they offer fulfils minimal quality requirements. However, some issues may be raised with regard to in-service training. On one hand, HEI for their mission should be expected to offer more up to date and innovative courses (Hénard & Roseveare, 2012) in all the teacher education dimensions. Nevertheless, even though there are six HEI (versus 32 SNTC) in the geographic area considered for the purpose of this study, the number of courses they offer and that are targeted to the population of this study is quite low and it could be argued that many teachers may not be able to enter a course offered by a HEI. Teachers can ask HEI to offer a specific training course but teachers may feel afraid of approaching it to ask for training. Therefore, there may be a problem with HEI in-service training offer: HEI may not offer courses because teachers do not look for them; and if HEI do not offer courses, then teacher cannot choose them. Also, HEI formative offer is a top-down one that may be disconnected from teachers' real needs (Hénard & Roseveare, 2012).

On the other hand, most SNTC teacher trainers are experienced teachers (OECD, 2013) which are expected to offer quite practical and contextualized courses. However, they are not professional science education researchers and therefore cannot be expected to be as much specialists on the course issues as HEI teacher trainers should be. Consequently, they may not be enough up dated in terms of recent science education knowledge. However, they may be easier to approach by their colleagues to organise a specific training course. This bottom-up approach gives rise to a sense of empowerment and confidence favours collaborative, interactional (Coolahan, 2002) and context dependent training techniques. In addition, SNTC offer in-service training free of charge and organize it in (or very near) the place where teachers work, while HEI charge teachers for course attendance and may be far away from the school where they teach. Nevertheless, OECD (2013) emphasizes the importance of external assistance to the process of in-service teacher education, such as support from HEI, education centres, and regional or specialist support teams.

However, if in-service training is to have any positive effect on teacher professional development, the in-service training courses that qualify for teachers' progression should be well identified so that teachers do not complete the required credits with courses that give a limited contribution for their professional knowledge base and that have low relevance for improving science teaching in schools.

According to Coolahan (2002), in-service training needs may have two main origins: education system needs, which may be regarded as being prominent; and the personal and individual needs of the teachers. As the former cannot exclude the latter, the challenge is to find ways of combining trainings with the two aims as well as trainings offered by the diverse types of training institutions, namely by HEI and SNTC, and given by qualified teacher educators. As most teacher educators' have no training (Bayrakci, 2010), this may require the definition of general and content dependent teacher educator's profiles as well as the formalization of a teacher educator's development system.

A coherent system of professional development activities for teacher educators should be based on knowledge and research regarding the work and learning of teacher educators (OECD, 2013). In addition, and in order to improve in-service training, teacher educators' accreditation should be stricter and require a specialization on the issues the courses focus on, which may require support in terms of their own educational and professional development.

ACKNOWLEDGEMENTS

This work is funded by CIEd – Research Centre in Education, Institute of Education, UMinho, UID/CED/01661/2013 - through national funds of FCT/MCTES-PT.

REFERENCES

Anderson, D. (2015). The nature and influence of teacher beliefs and knowledge on the science teaching practice of three generalist New Zealand primary teachers. *Research in Science Education*, *45*(3), 395-423. doi: 10.1007/s11165-014-9428-8.

Angell, C., Guttersrud Ø., & Henriksen, E. (2004). Physics: frightful, but fun: pupils' and teachers' views of physics and physics teaching. Science Education, *88*, 683-706.

Bayrakci, M. (2010). In-Service teacher training in Japan and Turkey: a comparative analysis of institutions and practices. *Australian Journal of Teacher Education, 34*(1), 10-22.

Bell, B. (2005). *Learning in science*. London: Routledge.

Berry, A. & Loughran, J. (2012). Developing science teacher educators' pedagogy of teacher education. In B. Fraser, K. Tobin, & C. McRobbie (Eds.), *Second international handbook of science education* (pp. 401-416). Dordrecht: Springer.

Bianchini, J. (2012). Teaching while still learning to teach: beginning science teachers' views, experiences, and classroom practices. In B. Fraser, K. Tobin, & C. McRobbie (Eds.), *Second international handbook of science education*, Vol. 24 (pp. 389-400) Dordrecht: Springer.

Blonder, R., Benny, N., & Jones, M. (2014). Teaching self-efficacy of science teachers. In R. Evans, J. Luft, C. Czerniak, & C. Pea (Eds.), *The role of science teachers' beliefs in international classrooms: from teacher actions to student learning* (pp. 3-16). Rotterdam: Sense Publishers.

Castro, R. (2015). Teacher education in Portugal: a history of transitions. In L. Leite, M. Flores, L. Dourado, M. Vilaça, & S. Morgado (Orgs.), *Proceedings of the ATEE annual conference 2014 - transitions in teacher education and professional identities* (pp. 3-14). Brussels: ATEE. https://repositorium.sdum.uminho.pt/handle/1822/36281?locale=en. Accessed 14 November 2015.

Coolahan, J. (2002). Teacher education and the teaching career in an era of lifelong learning. *OECD education*, 2. doi: 10.1787/226408628504.

Davies, P. (1999). What is evidence-based education? *British Journal of Educational Studies*, *47*(2), 108-121.

Day, C. & Sachs, J. (2004). Professionalism, performativity and empowerment: discourses in the politics, policies and purposes of continuing professional development (pp. 3-32). In C. Day, & J. Sachs (Eds.), *International handbook on the continuing professional development of teachers*. Maidenhead: Open University Press.

Dillon, J. & Maguire, M. (2007). Developing as a beginning teacher. In J. Dillon, & M. Maguire (Eds.), *Becoming a teacher: issues in secondary teaching*, 3rdEd. (pp. 3-25). Berkshire: Open University Press.

Eurydice (2011). *Science education in Europe: national policies, practices and research*. Brussels: Eurydice. http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/133en.pdf. Accessed 15 September 2015.

Eurydice (2015). *The teaching profession in Europe: practices, perceptions, and policies. Eurydice Report.* Luxembourg: Publications Office of the European Union.

Flores, M. & Day, C. (2006). Contexts which shape and reshape new teachers' identities: a multi-perspective study. *Teaching and Teacher Education*, *22*, 219-232. doi: 10.1016/ j.tate.2005.09.002.

Frost, J. (2010). Learning to be a science teacher. In J. Frost (Ed.) *Learning to teach science in the secondary school: a companion to school experience* 3Ed. (pp. 2-10). New York: Routledge.

Gil-Pérez, D. (1991). ¿Qué han de saber y saber hacer los profesores de ciencias? *Enseñanza de las Ciencias*, *9*(1), 69-77.

Goodwin, A. & Kosnik, C. (2013) Quality teacher educators = quality teachers? Conceptualizing essential domains of knowledge for those who teach teachers. *Teacher Development*, *17*(3), 334-346. doi:10.1080/13664530.2013.813766.

Hargreaves, A. (1998). The emotional practice of teaching. *Teaching and Teacher Education*, *14*(8), 835-854.

Harrison, C. & Killion, J. (2007). Ten roles for teacher leaders. *Teachers as Leaders, 65*(1), 74-77.

Hénard, F. & Roseveare, D. (2012). Fostering quality teaching in higher education: policies and practices. *OECD Publishing*. https://www.oecd.org/edu/imhe/QT%20policies%20and%20practices.pdf. Accessed 04 August 2016.

Henze, I. & van Driel, J. (2015). Toward a more comprehensive way to capture PCK in its complexity. In A. Berry, P. Friedrichsen, & J. Loughran (Eds.), *Re-examining pedagogical content knowledge in science education* (pp. 120-134). New York: Routledge.

Hilton, G., Flores, M., & Niklasson, L. (2013). Teacher quality, professionalism and professional development: findings from a European project. *Teacher Development*, 17(4), 431-447. doi: 10.1080/13664530 .2013.800743.

Hung, W., Jonassen, D., & Liu, R. (2008). Problem-based learning. In *Handbook of research on educational communications and technology*, edited by M. Spector, D. Merrill, J. van Merrienboer, & M. Driscoll, 485-506. New York: Lawrence Erlbaum Associates.

Kazempour, M. & Sadler, T. (2015) Pre-service teachers' science beliefs, attitudes, and self-efficacy: a multi-case study. *Teaching Education*, 26(3), 247-271. doi:10.1080/10476210.2014.996743.

Korthagen, F. (2010). How teacher education can make a difference. *Journal of Education for Teaching, 36*(4), 407-423. doi:10.1080/02607476.2010.513854.

Lederman, N. & Lederman, J. (2015). The status of preservice science teacher education: a global perspective. *Journal of Science Teacher Education, 26*, 1-6. doi: 10.1007/s10972-015-9422-7.

Leite, C. (2005). Percursos e tendências recentes da formação de professores em Portugal. *Educação*, *3*(57), 371-389.

Luehmann, A. (2007). Identity development as a lens to science teacher preparation. *Science Education, 91*, 822-839. doi: 10.1002/sce.20209.

Mansour, N. (2009). Science teachers' beliefs and practices: issues, implications and research agenda. *International Journal of Environmental & Science Education, 4*(1), 25-48.

Marcelo, C. (2009). Professional development of teachers: past and future. *Sísifo: Educational Sciences Journal*, *8*, 5-20.

Mestre, L. (2012). *Designing effective library tutorials: a guide for accommodating multiple learning styles.* Oxford: Chandos Publishing.

Mortimer, E. (2002). Uma agenda para a pesquisa em educação em ciências, *Revista Brasileira de Pesquisa em Educação em Ciências*, *2*(1), 36-59.

Murray, J. (2014). Teacher educators' constructions of professionalism: a case study. *Asia-Pacific Journal of Teacher Education, 42*(1), 7-21. doi:10.1080/1359866X.2013.870971.

Musset, P. (2010). *Initial teacher education and continuing training policies in a comparative perspective: current practices in OECD countries and a literature review on potential effects*. OECD Publishing. http://dx.doi.org/10.1787/5kmbphh7s47h-en. Accessed 14 September 2015.

National Research Council (2010). *Preparing teachers: building evidence for sound policy*. Washington: the National Academies Press.

O'Dwyer, J. & Atlı, H. (2015). A study of in-service teacher educator roles, with implications for a curriculum for their professional development. *European Journal of Teacher Education*, *38*(1), 4-20. DOI: 10.1080/02619768.2014.902438.

OECD (2013). Supporting teacher educators: for better learning outcomes. OECD Publishing. http://ec.europa.eu/education/school-education/teacher-cluster_en.htm. Accessed 22 March 2016.

OECD (2014a). *TALIS 2013 results: an international perspective on teaching and learning. OECD Publishing*. http://dx.doi.org/10.1787/9789264196261-en. Accessed 14 September 2015.

OECD (2014b). Education at a Glance 2014. OECD Indicators, *OECD Publishing*. http://dx.doi.org/10.1787/ eag-2014-en. Accessed 14 September 2015.

Ogunniyi, M. & Rollnick, M. (2015). Pre-service science teacher education in Africa: prospects and challenges. *Journal of Science Teacher Education, 26*, 65-79. doi: 10.1007 /s10972-014-9415-y.

Paixão, M., Lopes, B., Guerra, C., & Cachapuz, A. (2008). Where are we? A contribution to a better understanding of the state of the art in science education research. *Journal of Science Education*, *9*(1),4-8.

Ponte, J. (2006). Os desafios do processo de Bolonha para a formação inicial de professores. *Revista da Educação*, *14*(1), 19-36.

Pritchard, A. (2009). *Ways of learning: learning theories and learning styles in the classroom*. London: Routledge.

Rebmann, K., Schloemer, T., Berding, F., Luttenberger, S., & Paechter, M. (2015). Pre-service teachers' personal epistemic beliefs and the beliefs they assume their pupils have. *European Journal of Teacher Education, 38*(3), 284-299. http://dx.doi.org/10.1080/02619768.2014.994059. Accessed 10 December 2015.

Saka, Y., Southerland, S., Kittleson, J., & Hutner, T. (2013). Understanding the induction of a science teacher: the interaction of identity and context. *Research Science Education*, *43*, 1221-1244. doi: 10.1007/s11165-012-9310-5.

Schneider, R. (2015). Pedagogical content knowledge reconsidered: a teacher educator's perspective. In A. Berry, P. Friedrichsen, & J. Loughran (Eds.), *Re-examining pedagogical content knowledge in science education* (pp. 162-177). New York: Routledge.

Sickel, A., Banilower, E., Carlson, J., & van Driel, J. (2015). Examining PCK research in the context of current policy initiatives. In A. Berry, P. Friedrichsen, & J. Loughran (Eds.), *Re-examining pedagogical content knowledge in science education* (pp. 199-213). New York: Routledge.

Snoek, M. & Zogla, I. (2009). Teacher education in Europe; main characteristics and developments. In A. Swennen & M. Klink (Eds.), *Becoming a teacher educator: theory and practice for teacher educators* (pp. 11-27). Dordrecht: Springer.

Stenberg, K., Karlsson, L., Pitkaniemi, H., & Maaranen, K. (2014). Beginning student teachers' teacher identities based on their practical theories. *European Journal of Teacher Education*, *37*(2), 204-219.

Treagust, D., Won, M., Petersen, J., & Wynne, G. (2015). Science teacher education in Australia: initiatives and challenges to improve the quality of teaching. *Journal of Science Teacher Education, 26*, 81-98. doi: 10.1007/s10972-014-9410-3.

Wallace, C. (2014). Overview of the role of teacher beliefs in science education. In R. Evans, J. Luft, C. Czerniak,

& C. Pea (Eds.), *The role of science teachers' beliefs in international classrooms: from teacher actions to student learning* (pp. 17-31). Rotterdam: Sense Publishers.

Wallace, J. & Loughran, J. (2012). Science teacher learning. In B. Fraser, K. Tobin, & C. McRobbie (Eds.), *Second international handbook of science education*, Vol. 24 (p. 295-306). Dordrecht: Springer.

Yassin, B. & Almasri, M. (2015). How to accommodate different learning styles in the same classroom: analysis of theories and methods of learning styles. *Canadian Social Science, 11*(3), 26-33. doi: 10.3968/6434.

Zeichner, K. (2010). Rethinking the connections between campus courses and field experiences in college- and university-based teacher education. *Journal of Teacher Education*, *61*(1-2), 89-99. doi: 10.1177/0022487109347671.

Zhang, M., Parker, J., Koehler, M., & Eberhardt, J. (2015). Understanding in-service science teachers' needs for professional development. *Journal Science Teacher Education*, *26*, 471-496. doi: 10.1007/s10972-015-9433-4.